# STATEMENT OF WORK

# AIRBORNE TOTAL WATER CONTENT (TWC) AND LIQUID WATER CONTENT (LWC) PROBE WITH ASSOCIATED SOFTWARE AND ELECTRONICS

## For NASA's Global Precipitation Measurement Mission

## 1 Background

The objective of this work is to manufacture an airborne probe that is capable of measuring cloud liquid water content (LWC) and total condensed (water+ice) water content (TWC). The TWC/LWC probe is planned for deployment as part of the Mid-Continent Convective Clouds Experiment (MC3E), a major field campaign sponsored in part by NASA's Global Precipitation Measurement (GPM) mission. The MC3E campaign is scheduled for mid-April through May 2011 in Oklahoma. The TWC/LWC probe will be manifested on the University of North Dakota's Cessna Citation II fanjet aircraft for operations during MC3E.

Data collected by the TWC/LWC probe will be used for the development and validation of data product generation algorithms used as part of the GPM mission. The GPM satellite is scheduled for launch in 2013, but the TWC/LWC probe will be used in the pre-launch era as part of field campaigns that will collect data for GPM algorithm development. The algorithms developed with the help of data collected by the TWC/LWC probe will be used in the generation of at-launch global precipitation products. These precipitation products are expected to be used in numerous practical applications including weather forecasting and climate modeling.

## 2 Period of Performance

The period of performance for this SOW begins on the date of award and continues for up to six (6) months.

## 3 Statement of Work

The Contractor shall provide the personnel, facilities, and materials necessary to design, fabricate, assemble, test, and deliver each of the following:

- One (1) TWC/LWC probe suitable for flight on the wing of the University of North Dakota's Cessna Citation II aircraft
- One (1) set of associated electronics and software necessary for TWC/LWC probe operations, data collection, and data product generation
- One (1) set of documentation describing the installation and operations of the TWC/LWC probe.

The Contractor shall provide air freight shipment for all deliverables to:

Dr. Mathew Schwaller
NASA/GSFC Mail Code 422
Building 16 Room 140
8800 Greenbelt Road
Greenbelt, Maryland, USA 20771

Phone: +1-301-614-5382
Fax: +1-301-286-1737
Email: mathew.r.schwaller@nasa.gov

## 4 TWC/LWC Probe Requirements

The TWC/LWC Probe Contractor shall perform all of the following requirements.

4.1 The TWC/LWC Probe shall be capable of measuring TWC and LWC in clouds composed of water or ice with a minimum total water content of $\leq 0.003$ g/m$^3$.

Note: TWC/LWC Probe contractors may verify compliance with this requirement by citing papers published in peer-reviewed scientific literature. Other evidence of compliance will also be accepted.

4.2 The TWC/LWC Probe shall be capable of measuring TWC and LWC in clouds composed of water or ice with a maximum total water content of $\geq 3.0$ g/m$^3$.

Note: TWC/LWC Probe contractors may verify compliance with this requirement by citing papers published in peer-reviewed scientific literature. Other evidence of compliance will also be accepted.

4.3 The TWC/LWC Probe head shall have the capability of being mounted on the wingtip of the UND Cessna Citation II aircraft.

Rationale: NASA requires that the TWC/LWC Probe operate within the free air stream in undisturbed air flow. Fuselage mounting locations are not acceptable. Probes that can only be mounted on the UND Citation fuselage are not responsive to this solicitation.

Note: TWC/LWC Probe contractors may verify compliance with this requirement by citing previous heritage, including participation in NASA field campaigns, where probes of similar or identical design were integrated on the wing of the UND Citation or similar aircraft.

4.4 The TWC/LWC Probe support electronics shall be fully contained in the probe's externally-mounted sensing unit.

Note: TWC/LWC Probe control unit can be located within the cabin of the UND Citation aircraft.

Note: As described in 4.3, the probe and support electronics will be mounted on the wing tip of the UNC Citation aircraft.

4.5 The TWC/LWC Probe head shall have a weight not to exceed 10 pounds.

Note: TWC/LWC Probe head is defined as the part of the instrument (probe and support electronics) that is mounted externally on the wing of the UND Citation aircraft.

4.6 The TWC/LWC Probe control unit shall weigh no more than 100 pounds and have a volume not to exceed 20x24x19 inches of standard rack space.

Note: TWC/LWC Probe control unit is defined as the part of the instrument that contains support electronics and that is mounted within the pressurized cabin of the UND Citation aircraft.

4.7 The TWC/LWC Probe shall be capable of measuring TWC and LWC at altitudes from sea level up to 40,000 feet and at air speeds of up to 300 knots.

Note: The TWC/LWC Probe Contractor may verify compliance with this requirement by citing previous heritage, including participation in NASA field campaigns, where probes of similar or identical design were integrated on the wing of the UND Citation or similar aircraft. Other evidence of compliance will also be accepted.

4.8 The TWC/LWC Probe shall have a heritage of successful flight operations in previous NASA field campaigns.

Rationale: The TWC/LWC Probe will be used in field campaigns to support algorithm development for the GPM spaceflight mission. Because the launch schedule for GPM is fixed, there is no opportunity to re-do microphysical measurements if for some reason the TWC/LWC probe malfunctions during the MC3E campaign, or any of the other of the GPM field campaigns. To reduce risk, NASA requires a TWC/LWC probe with demonstrable heritage of success in similar field campaigns.

Note: TWC/LWC Probe contractors may verify compliance with this requirement by citing previous heritage, including participation in NASA field campaigns, where probes of similar or identical design were integrated on the wing of the UND Citation or similar aircraft.

4.9 The TWC/LWC Probe shall have supply voltage of 110 V at 60 Hz or 28 VDC.

Note: Both supply voltages are available on the UND Citation aircraft. The probe and electronics may use either or both.

4.10 The TWC/LWC Probe shall have a power consumption not to exceed 10A 110 VAC plus 20A 28VDC (sensor), plus 20A 28 VDC deicing.

4.11 The TWC/LWC Probe shall have an operating temperature range (exterior part) of -40° C to +35° C.

4.12 The TWC/LWC Probe shall have and operating temperature range (cabin part) of 0° C to +40° C.

4.13 The TWC/LWC Probe shall have a 12-month warranty for hardware and software materials and workmanship.

4.14 The TWC/LWC Probe Contractor shall provide documentation, including the following:

a. Theory of operation
b. Probe specifications, including: weight, size, and power requirements; mechanical mount; environmental limitations
c. Wiring diagram
d. Data signal description
e. Installation instructions
f. Calibration information
g. Maintenance instructions.

**Deliverable Items List and Schedule**

| Item | Delivery Date | Quantity |
|---|---|---|
| TWC/LWC Probe with associated electronics and software | No more than 6 (six) months following award | 1 (one) |
| TWC/LWC documentation | No more than 6 (six) months following award | 1 (one)<br>Note: documentation may be in electronic form |
| 12-month warranty for hardware and software materials and workmanship | Starting on date of shipment of the TWC/LWC Probe | 1 (one), applies to all hardware and software items received |